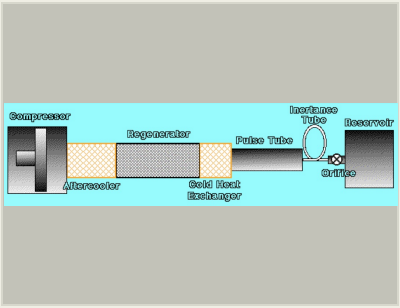
Cryocooler With Cold Compressor for Deep Space Applications, Phase I

Completed Technology Project (2013 - 2013)

Project Introduction

The unique built-in design features of the proposed mini pulse tube cryocooler avoid all thermal expansion issues enabling it to operate within a cold, 150 K environment. As such, the cooler addresses the need to prevent boiloff of cryogenic propellants on long duration remote missions. Due to its high heat capacity regenerator matrix, the cooler has a high efficiency and a small footprint, making its launch mass minimal. The coherent regenerator matrix configuration prevents movement and so prevents degradation over time. Due to its unique compressor being cold-tolerant down to 150 K the cooler can keep running even where the sun is so far away and dim that the energy captured by the spacecraft cannot keep the compressor warm. The compressor being designed to run cold and on minimal input power allows it to run at the inherently low solar intensity, which seriously depresses solar cell power generation. In all, our cryocooler innovation is an enabling technology for far-flung missions that have the need to preserve mission propellants in their liquefied state until needed to maneuver near a destination or a midway point. The design concept calls for: 1) Using regenerator materials from a recently developed class of high heat capacity rare earth alloys; 2) A compressor and coldhead design optimized for a low temperature heat sink; 3) Minimizing the known losses in the pulse tube proper. The cryocooler design will be possible due to the long standing cryocooler design and manufacture heritage of the team members. Phase I will verify the low temperature capabilities down to 150 K of an available mini compressor, and, will put forth the design of the crucial components of a complete 0.3 W at 35 K cryocooler targeted to run in a 150 K environment. Phase II will build and test a complete prototype cryocooler that is small in size and power consumption enabling long durations missions to planetary objects at remote locations within the solar system.



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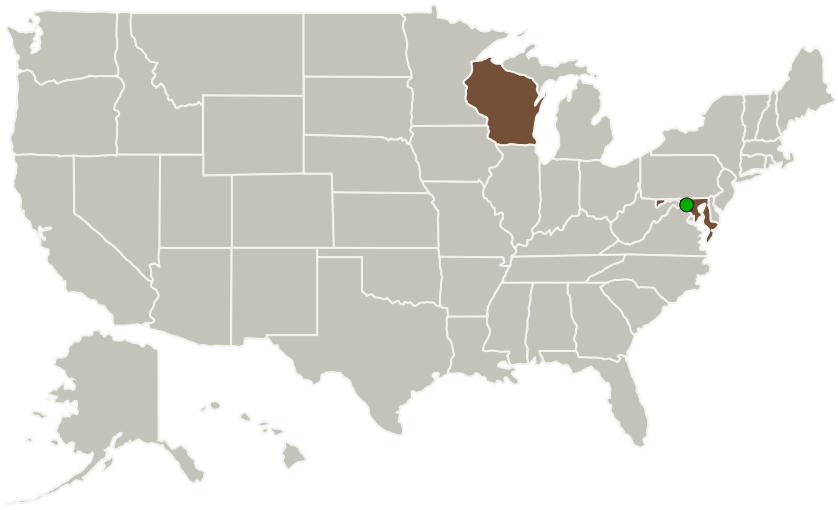
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Madison CryoGroup, LLC	Lead Organization	Industry	Middleton, Wisconsin
Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations	
Maryland	Wisconsin

Project Transitions

May 2013: Project Start

November 2013: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/140436)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Madison CryoGroup, LLC

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Ben P Helvensteijn

Co-Investigator:

Ben Helvensteijn

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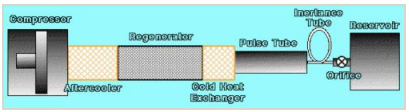
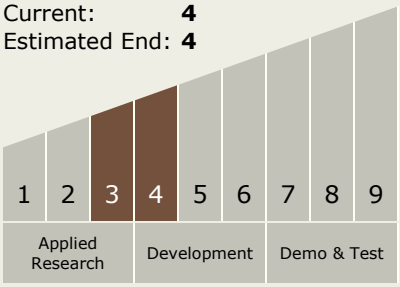
Images



Project Image
Cryocooler With Cold Compressor for Deep Space Applications
(https://techport.nasa.gov/image/128405)

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**



Technology Areas

Primary:

- TX14 Thermal Management Systems
  - TX14.1 Cryogenic Systems
    - TX14.1.1 In-space Propellant Storage & Utilization

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System